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AN ASSESSMENT OF WATER QUALITY AND LANDUSE DYNAMICS DUE TO ANTHROPOGENIC INTERFERENCES: A CASE STUDY OF MANSAR WETLAND, J&K

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ABSTRACT

The Mansar wetland in Jammu and Kashmir has its own importance in terms of livelihood and sustainability for the inhabitants residing nearby. Because of its scenic beauty, religious and recreational importance, the wetland is under great anthropogenic pressure not only by local residents but also by tourists from different parts of the country. Severe changes in the ecology of the wetland including deterioration of water quality and land use and land cover changes (LULC) has been inflicted as a result of the influx of domestic sewage, animal excreta, agricultural runoff (fertilizers and pesticides), detergents and setting of several boating stations, construction activities in the vicinity. Land use and land cover (LULC) changes in the wetland catchments are the direct and indirect consequence of human actions to secure essential resources. So, looking at the multifarious benefits and importance of the wetland, the present study has been done to assess the water quality and land use dynamics due to Anthropogenic Interferences. The present study is primarily based on primary sources of data and satellite data. Collected data has been assessed to draw the conclusion based on identified objectives.

KEYWORDS: Mansar, Land use Land Cover (LULC), Landuse Dynamics, Wetland & Water Quality

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A CASE STUDY

INTRODUCTION

Wetlands are lands transitional between terrestrial and aquatic systems where an oversupply of water for all or part of the year results in distinct wetland communities (Clarkson and Ausseil, 2013). There are many different types of wetland. These include areas of marsh, fen, peat land and shallow water bodies. Most are natural but some are human made, and they can be permanent or seasonal. The water in wetlands can be flowing or static, and can be fresh, brackish or saline. Marine water that does not exceed 6 meters depth at low tide is also classed as a wetland, and many river estuaries are globally significant wetlands Wetland functions and thus values have the potential to last for a very long time. Modern agriculture or industrial: commercial activities are generally unsustainable and resource-depleting (soil loss; use of fossil fuels) so the lifetime of these human-based alternatives is short-lived (Mitsch & Gosselink, 2000). As elsewhere the wetlands play an important role in the economic, socio-cultural and religious activities of the people in Jammu and Kashmir. They are also the source of tourist as they provide the scenic beauty and the best source of adventurous tourism. The influx of tourist in these areas provides the source of livelihood for many peoples in this area by providing employment as well as other source of income. Considered as a holy site from mythological period, Mansar wetland shares the sanctity and legacy of Mansarovar and is socially

and culturally very important. It owes its origin to Mahabharata period. Besides, wetland also provides an important habitat and breeding ground for fishes and other aquatic life. Numerous migratory birds visit the wetland during winters. Many cultures do live in and among wetlands and use them for daily subsistence the production of food and fiber (Mitsch & Gosselink, 2000).

Wetlands also attract diverse recreational and ecotourism activities, generating significant incomes that benefit local communities and national economies (Ramsar 2009g). The scenic beauty and religious place make Mansar Wetland an important place for tourism. Many tourists from different part of the country visit this place. Due to various tourism activities like boating, religious ceremonies, many local inhabitants involvements make it a good source of livelihood. Many people from nearest areas settled down near wetland as they involve in many activities for their livelihood. The wetland provides the scenic beauty as well as has its importance for aesthetic value, the people living near the wetland mainly depend on the resources and these are dynamics in nature. The forest area has been cleared down for agriculture as the main occupation of the people living near the wetland is agriculture beside other secondary activity. As stated above, subsistence-based economies focus on the hunting, fishing, gathering, and trapping of local resources. The predominant identifying trait of such economies is their dynamic adaptive nature, which changes over time and in accordance with fluctuations in the annual and seasonal resource base (Ellanna and wheeler, 1989). Ramsar gives its definition of wise use of wetlands: "Wise use of wetlands is the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development. " This pair of wetlands was declared as Ramsar sites on 08/11/2005 owing to the compliance of criteria 2, 3 & 4 as Wetland supports globally threatened ecological communities. It also supports populations of animal/plant species important for maintaining biological diversity and provides refuge to wildlife during adverse condition. (National Wetland Atlas, 2013) It is found that the wetland provides employment to lotsof people as the people open many shops, commercial outlets near the wetland due to increase in number of tourist. The lack of connectivity hinders the pace of development in Mansar as in rainy season there are blockage of road as a results of landslides and the condition of road get deteriorated. The study has been done to find out the dependence of local inhabitants on wetland for livelihood.

OBJECTIVES

- To assess the temporal changes in land-use dynamics within the catchment area of the Wetland.
- To analyse the water quality status of Mansar Wetland.

METHODOLOGY

To find out the anthropogenic interference a five kilometers buffer around each wetland taken under study has been created. Keeping in view the spatial resolution of data used and total buffer area taken for study visual interpretation technique has been considered most appropriate for classifying the image and making LULC map. The major land use/ land cover in the study area was recognized as agriculture, barren land, moderate dense forest, open forest, river, river sand, scrub, settlement and water body. To see the changes over time LULC maps were prepared for the year 2008 and 2018 using landsat data.

Software used

Erdas Imagine 9.2

ERDAS IMAGINE a remote sensing application software, commonly used for the processing of images.

ArcGIS 10.5

ArcGIS is a suit consisting of a group of geographic information system (GIS) software products for working with maps and geographic information. It is used for compiling geographic data, analyzing mapped information, sharing and discovering geographic information and managing geographic information in a database.

The sampling was carried manually using a water sampler. The collected samples were transferred to transparent polyethylene bottles, which was thoroughly cleaned and rinsed three times with the water which was sampled. Two-date sample data, one set acquired during March to May and another during October to November (acquired during 2015-2018) were used to capture the pre-monsoon and post-monsoon hydrological variability of the wetlands respectively.

Estimation of physico-chemical parameters viz. temperature, transparency, turbidity, pH, electrical conductivity, TDS bicarbonate, dissolved oxygen, calcium, magnesium, sodium, chloride, phosphate, sulphate and nitrate of water samples were carried out in the laboratory. Methodology adopted for water analysis is as under:

Physical Parameters

- **Water Temperature:** Water temperature was recorded with the help of a mercury centigrade thermometer graduated up to 110ºC with 0.1 º C graduations. This was done by vertically dipping the thermometer into the water (Welch, 1952).
- **Transparency:** The transparency of the water was determined by Secchi disc of 20 cm in diameter (painted black and white on the upper surface) and computed by the formula:

  T = X + Y / 2 (Welch, 1952) Where, T = transparency in cm, X = depth at which the disc become invisible and Y = depth at which the disc reappeared while pulling the rope upward.
- **Turbidity:** Turbidity of water was observed by turbidity meter (model 331 E).

Chemical Parameters

- **pH:** pH of water sample was determined with the help of a portable field pH meter (Hanna).
- **Electrical Conductivity and TDS:** Electrical Conductivity and TDS were measured by Century water/ soil analyser kit, CMK 731
- **Bicarbonates:** Bicarbonate was determined in the laboratory following the potentiometric titration method.
- **Dissolved Oxygen:** Dissolved Oxygen was determined by Sodium Azide Modification of Winkler's Method.
- **Calcium and Magnesium:** The estimation of calcium and magnesium was done by the EDTA- titrimetric method suggested in.
- **Sodium:** Sodium and potassium were analyzed on a flame photometer

- **Chloride:** The chloride was determined by titration of the water sample against silver nitrate with potassium chromate as an indicator.
- **Phosphates:** Total phosphate was determined by Stannous chloride method using spectrophotometer.
- **Sulphates:** Sulphates were estimated by Turbiditimetric method using spectrophotometer.
- **Nitrate:** Nitrates were estimated by Phenol Disulphonic acid method using spectrophotometer.

Study Area

Located between the forest covered hills, Mansar Wetland is about 62Kms from Jammu city. Its length is 2.5 kms and width is 1.5 kms. Wetland Mansar, revered for being the seat of Sheshnag, is a sub-tropical, beautiful, Natural wetland located between 75°5′11.5″to 75° 5′12.5″E longitude and 32°40′58.25″to 32° 40′59.25″N latitude at an elevation of 665 meters in the east of Jammu city. The wetland is a sub-oval shaped, closed lacustrine system with no surface channels flowing into it. The wetland receives fresh water from the sub-terranean springs and surface run-off. The wetland is surrounded by 700-800m tall hills forming an evergreen canopy of diverse plant species. The history of both the wetlands Surinsar and Mansar goes back to the period of Mahabharata. In keeping view of the importance of place both religious and tourism point, there is an influx of lot of tourist from all over the country. The tourism department holds boating fun for visitors on the water of Mansar Wetland. Known for flora and fauna, the wetland is visited by a number of seasonal birds, tortoise and fishes of different species. The area has a wild life Sanctuary with animals including Spotted Deer, Neelgai and water birds such as Cranes and Ducks among others.

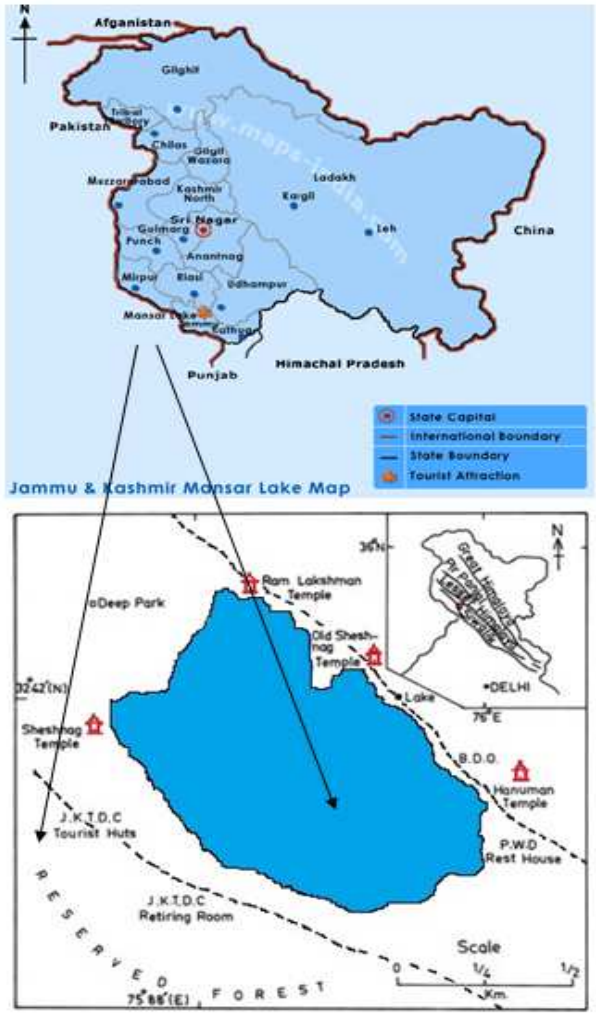


Figure 1: Location Map of Study Area

Changing Land use / Land Cover of Mansar Wetland (2008-2018)

The land use/land cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. Land-use and land-cover change, as one of the main driving forces of global environmental change, is central to the sustainable development debate. Land use and land-cover changes have impacts on a wide range of environmental and landscape attributes including the quality of water, land and air resources, ecosystem processes and function, and the climate system itself through greenhouse gas fluxes and surface effects (Seto. 2002).

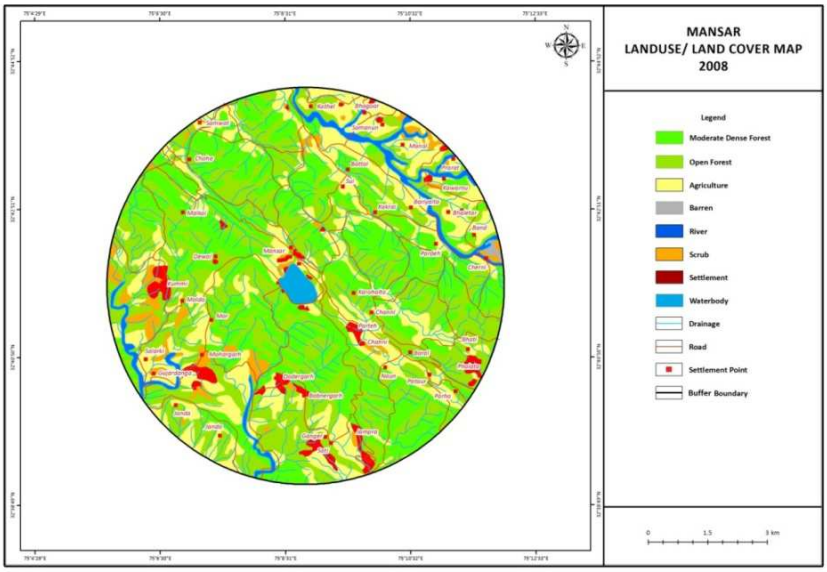
An attempt has been made in this study to examine the status of land use/ land cover (LULC) of the Mansar Wetland between 2008 and 2018.

Table 1: LU/LC Changes in Mansar Wetland Area over a Period of Ten Years

Classes	Area (in ha)2008	Area (in ha)2018	Change
Agriculture	1978.37	1981.39	3.02
Barren Land	10.75	4.38	-6.37
Moderate Dense Forest	2290.84	2442.1	151.26
Open Forest	2828.66	2671.07	-157.59
River	223.98	223.98	0.00
Scrub	279.3	273.64	-5.66

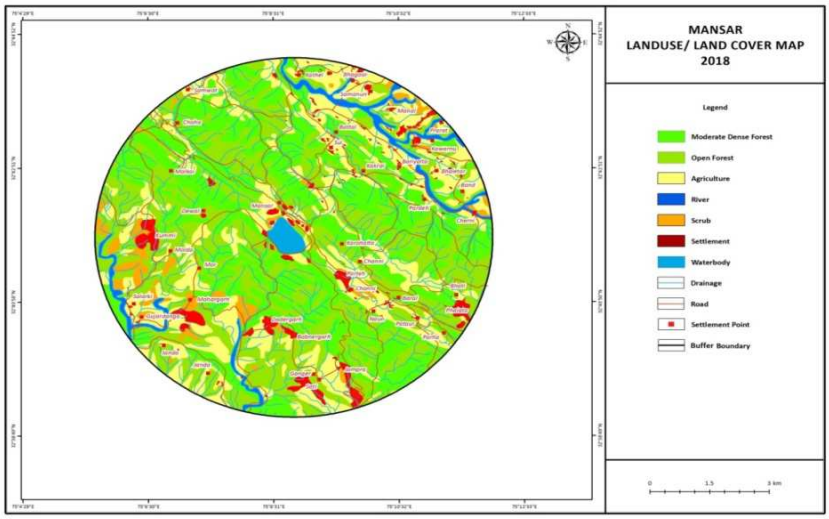
Table 1: Contd.,			
Settlement	180.57	195.92	15.35
Water body	61.26	61.26	0.00

Table 1 shows change in land use/ land cover over a period of ten years i.e. (between 2008 and 2018). Among all the land use/ land cover classes taken under study moderate dense forest shows highest increase in its area, it increases by 151.26 hectares. In 2008, area under open forest was 2828.66 hectares, but in 2018 open forest area declined to 2671.07 in 2011 with a negative change of 157.59 hectares. Barren land declined by 6.37 hectares and scrub decreased by 5.66 hectares. Moreover settlement and agriculture land increases. There is no change in water body, although are some seasonal fluctuations in the Mansar wetland. The detail analysis shows that there are negative changes in some classes due to their transformation into other classes e.g. open forest area is converted into moderate dense forests and settlement and barren land is converted into agriculture land.



Source: Generated from Land Sat Satellite Image, November, 2008

Figure 2



Source: Generated from Land Sat Satellite Image, December, 2018

Figure 3

Table 2: Water Quality Status of Mansar Wetland

Parameters	Units of Measurement	2015		2016		2017		2018		Average
		Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	
Water Temperature	□C	12	22	14	27	14	26	13	26	19.2
Transparency	Cm	42.5	45.0	25.0	40.0	30.0	35.0	21.2	45.0	35.4
Turbidity	NTU	6.8	12.9	6.2	14.5	6.2	10.7	6.4	15.8	9.93
pH	Unit	7.5	8.3	7.9	8.5	7.6	8.6	7.2	7.0	7.83
Electrical Conductivity	µS/cm	210	240	188	200	190	203	198	206	204.4
TDS	Ppm	120	135	130	150	128	138	127	136	133
HCO_3	mg/l	94	93	92	90	100	98	101.4	100.5	96.1
DO	mg/l	5.3	4.1	5.6	4.3	5.9	4.2	5.2	4.4	4.87
Calcium (Ca)	mg/l	21.7	18.6	23.3	20.0	23.3	20.1	23.8	20.3	21.4
Magnesium (Mg)	mg/l	5.0	6.3	3.5	4.5	6.3	7.8	6.1	7.6	5.88
Sodium (Na)	mg/l	10.4	10.2	9.5	11.5	10.5	10.6	10.5	10.8	10.5
Chloride (Cl)	mg/l	7.3	6.4	7.1	6.5	8.0	9.0	9.1	11.2	8.07
Phosphate (PO_4)	mg/l	0.03	0.05	0.03	0.05	0.04	0.05	0.04	0.05	0.04
Sulphate (SO_4)	mg/l	6.00	8.8	5.6	8.2	6.4	9.5	7.8	10.7	7.88
Nitrate (NO_3)	mg/l	0.66	0.40	0.60	0.40	0.69	0.40	0.38	0.22	0.46

Source: Sample Results from Central Water Commission (CWC), Jammu

During the present period of investigations, Mansar wetland recorded well marked seasonal variations in water temperature. Temperature data in above table revealed that in the first year of study (2015) water temperature recorded its value of 12ºC in the pre-monsoon & 22ºC in the post-monsoon period. However, during the second year, third year and fourth year (2016, 2017, 2018), the temperature recorded its values of 14ºC, 14ºC, 13ºC in the pre-monsoon & 27ºC, 26ºC, 26ºC in the post-monsoon periods. However the average water temperature of Mansar wetland is 19.2ºC.

Transparency of water showed increase in post-monsoon period while a decrease recorded in the pre-monsoon period. In the year 2015, the values for transparency varied from 42.5 cm (pre-monsoon) to 45.0 cm (post-monsoon). Whereas during the second year of present study 2016, transparency fluctuated from 25.0 cm (pre-monsoon) to 40.0 cm (post-monsoon). During third year 2017 and fourth year 2018 transparency values of water are 30.0cm and 21.2cm (pre-monsoon) and 35.0cm and 45.0cm (post-monsoon).

In the year 2015, the values for turbidity varied from 6.8 (pre-monsoon) to 12.9 cm (post-monsoon). Whereas during the second year of present study 2016, turbidity fluctuated from 6.2 cm (pre-monsoon) to 14.5 cm (post-monsoon). During third year 2017 and fourth year 2018 turbidity values of water are 6.2cm and 6.4cm (pre-monsoon) and 10.7cm and 15.8cm (post-monsoon).

During the first year (2015), pH fluctuated from 7.5 (pre-monsoon) to 8.3 (post-monsoon), during the second year (2016), pH fluctuated from 7.9 (pre-monsoon) to 8.5 (post-monsoon), during the third and fourth year of present study (2017 and 2018) pH fluctuated from 7.6 and 7.2 (pre-monsoon) to 8.6 and 7.0 (post-monsoon).

Electrical conductivity of water showed increase in post-monsoon period while a decrease recorded in pre-monsoon period. In the year 2015, the values for electrical conductivity varied from 210 µS/cm (pre-monsoon) to 240 µS/cm (post-monsoon). Whereas during the second year of present study 2016, electrical conductivity fluctuated from 188 µS/cm (pre-monsoon) to 200 µS/cm (post-monsoon). During third year 2017 and fourth year 2018 electrical conductivity values of water are 190 µS/cm and 198 µS/cm (pre-monsoon) and 203 µS/cm and 206 µS/cm (post-monsoon).

During the first year (2015), TDS fluctuated from 120 ppm (pre-monsoon) to 135 ppm (post-monsoon), during the second year (2016), TDS fluctuated from 130 ppm (pre-monsoon) to 150 ppm (post-monsoon), during the third and fourth year of present study (2017 and 2018) TDS fluctuated from 128 ppm and 127 ppm (pre-monsoon) to 138 ppm and 136 ppm (post-monsoon).

Perusal of table 3 indicated that the bicarbonate content in the four years of study i.e. from 2015 to 2018 showed its maximum value (94 mg/l, 92 mg/l, 100 mg/l& 101.4mg/l) in pre-monsoon period. On the other hand, minimum value of bicarbonate content (93 mg/l, 90 mg/l, 98 mg/l& 100.5mg/l)observed in post-monsoon period.

During 2015, the minimum values of DO recorded to be 5.3mg/l (pre-monsoon), 4.1 mg/l (post-monsoon), during the second year (2016), DO fluctuated from 5.6mg/l (pre-monsoon) to 4.3mg/l (post-monsoon), during the third and fourth year of present study (2017 and 2018) DO fluctuated from 5.9mg/l and 5.2mg/l (pre-monsoon) to 4.2mg/l and 4.4mg/l (post-monsoon).

Calcium content of water in four years of study i.e. from 2015 to 2018 showed that calcium content of water fluctuated from (21.7 mg/l, 23.3 mg/l, 23.3 mg/l & 23.8 mg/l) in pre-monsoon period to (18.6 mg/l, 20.1 mg/l, 20.1 mg/l & 20.3 mg/l) observed in post-monsoon period.

During the first year of investigations (2015) the level of magnesium fluctuated from 5.0 mg/l (pre-monsoon) to 6.3 mg/l (post-monsoon), during the second year (2016), magnesium fluctuated from 3.5 mg/l (pre-monsoon) to 4.5 mg/l (post-monsoon), during third and fourth year of present study (2017 and 2018) magnesium fluctuated from 6.3 mg/l and 7.8 mg/l (pre-monsoon) to 6.1 mg/l and 7.6 mg/l (post-monsoon).

Sodium content of water in four years of study i.e. from 2015 to 2018 showed that sodium content of water (10.4 mg/l, 9.5 mg/l, 10.5 mg/l & 10.5 mg/l) in pre-monsoon period to (10.2 mg/l, 11.5 mg/l, 10.6 mg/l & 10.8 mg/l) observed in post-monsoon period.

Chloride content of water in four years of study i.e. from 2015 to 2018 showed that sodium content of water (7.3 mg/l, 7.1 mg/l, 8.0 mg/l & 9.1 mg/l) in pre-monsoon period to (6.4 mg/l, 6.5 mg/l, 9.0 mg/l & 11.2 mg/l) observed in post-monsoon period.

During 2015, the minimum values of Phosphate recorded to be 0.03 mg/l (pre-monsoon), 0.05 mg/l (post-monsoon), during the second year (2015), Phosphate fluctuated from 0.03 mg/l (pre-monsoon) to 0.05 mg/l (post-monsoon), during the third and fourth year of present study (2017 and 2018) Phosphate fluctuated from 0.04 mg/l and 0.05 mg/l (pre-monsoon) to 0.04 mg/l and 0.05 mg/l (post-monsoon).

Sulphate content of water in four years of study i.e. from 2015 to 2018 showed that Sulphate content of water (6.00 mg/l, 5.6 mg/l, 6.4 mg/l& 7.8 mg/l) in pre-monsoon period to (8.8 mg/l, 8.2 mg/l, 9.5 mg/l& 10.7 mg/l)observed in post-monsoon period.

Nitrate content of water in four years of study i.e. from 2015 to 2018 showed that nitrate content of water (0.66 mg/l, 0.60 mg/l, 0.69 mg/l& 0.38 mg/l) in pre-monsoon period to (0.40 mg/l, 0.40 mg/l, 0.40 mg/l& 0.22 mg/l)observed in post-monsoon period.

Table 3: Mansar Wetland: Water Sample Results and BIS Comparison

Parameters	Units of Measurement	BIS criteria (Acceptable Limit)	Observed Value	Deviation from BIS Value
Water Temperature	□C	20	19.2	-0.8
Transparency	Cm	30	35.4	5.4
Turbidity	NTU	5	9.93	4.93
pH	Unit	7	7.83	0.83
Electrical Conductivity	µS/cm	325	204.4	-120.6

Table 3: Contd.,				
TDS	Ppm	500	133	-367
HCO_3	mg/l	600	96.1	-503.9
DO	mg/l	6	4.87	-1.13
Calcium (Ca)	mg/l	75	21.4	-53.6
Magnesium (Mg)	mg/l	30	5.88	-24.12
Sodium (Na)	mg/l	200	10.5	-189.5
Chloride (Cl)	mg/l	250	8.07	-241.93
Phosphate (PO_4)	mg/l	0.1	0.04	-0.06
Sulphate (SO_4)	mg/l	200	7.88	-192.12
Nitrate (NO_3)	mg/l	45	0.46	-44.54

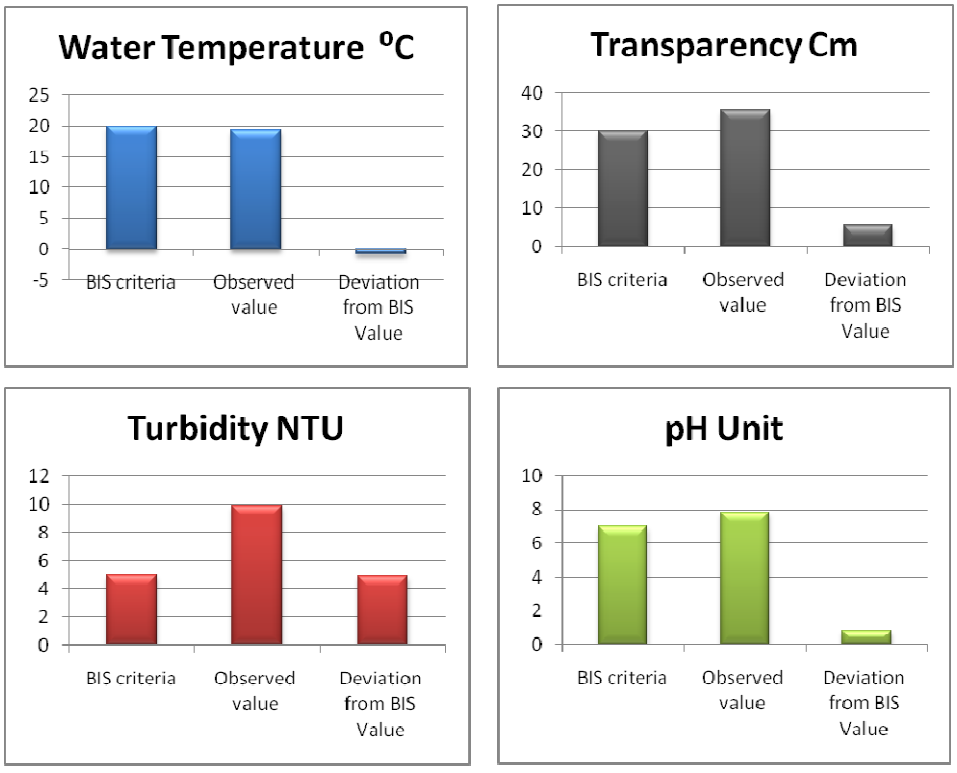
Source: Sample Results from Central Water Commission (CWC), Jammu.

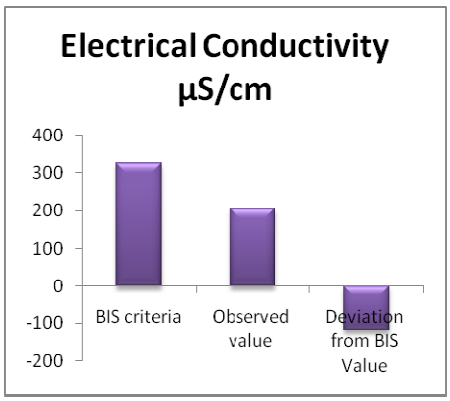
Table 3 portrays the sample results of different parameters (physical and chemical) like water temperature, transparency, turbidity, pH, Electrical Conductivity Calcium, Magnesium, Sodium, Chloride, Phosphate, Sulphate, and Nitrate etc. of Mansar wetland. These above results have been compared with well-established BIS criteria and the actual deviation of these observed results have been also chalked out in the last column of the above table.

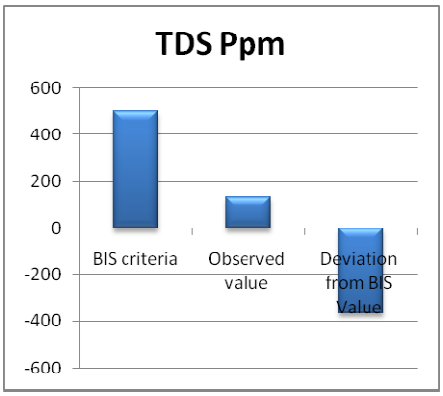
Only three parameters namely transparency of wetland water, its pH value as well as turbidity have recorded higher observed value than BIS criteria. On the other hand, electrical conductivity, dissolved oxygen as well as other salts dissolved has recorded their low proportion than BIS criteria. The amount of HCO_3 in the wetland is found to be least i.e. only 96.1mg/l as compared to 600mg/l according to BIS acceptable limit.

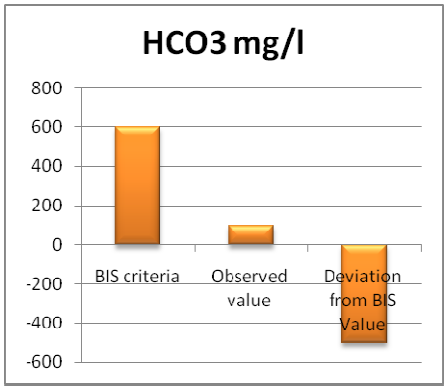
Also the Graph given below depicts more accurately these parameters individually. Each parameter has been shown in term of observed value of parameters, BIS Criteria and the deviation from BIS Value.

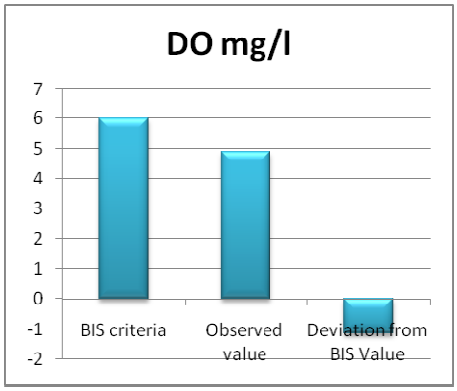
Graphs Showing Individual Observed Value of Water Parameters of Mansar Wetland along with BIS Criteria and the Deviation from BIS Value

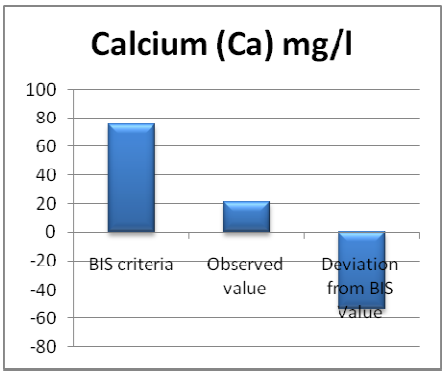


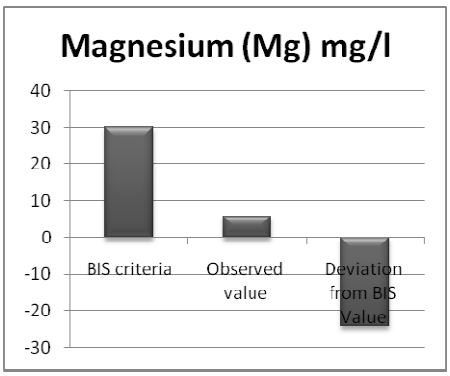

Electrical Conductivity µS/cm
400
300
200
100
0
-100
-200
BIS criteria
Observed value
Deviation from BIS Value

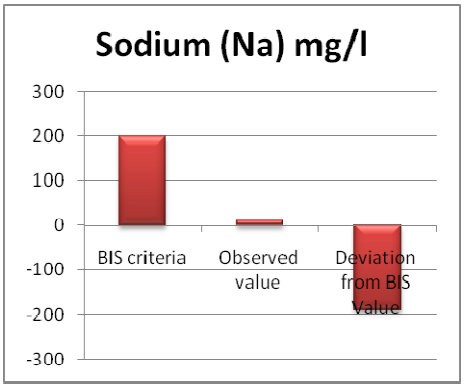

TDS Ppm
600
400
200
0
-200
-400
-600
BIS criteria
Observed value
Deviation from BIS Value

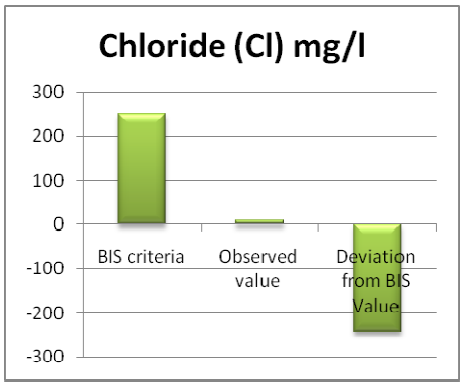

HCO3 mg/l
800
600
400
200
0
-200
-400
-600
BIS criteria
Observed value
Deviation from BIS Value


DO mg/l
7
6
5
4
3
2
1
0
-1
-2
BIS criteria
Observed value
Deviation from BIS Value


Calcium (Ca) mg/l
100
80
60
40
20
0
-20
-40
-60
-80
BIS criteria
Observed value
Deviation from BIS Value


Magnesium (Mg) mg/l
40
30
20
10
0
-10
-20
-30
BIS criteria
Observed value
Deviation from BIS Value


Sodium (Na) mg/l
300
200
100
0
-100
-200
-300
BIS criteria
Observed value
Deviation from BIS Value


Chloride (Cl) mg/l
300
200
100
0
-100
-200
-300
BIS criteria
Observed value
Deviation from BIS Value

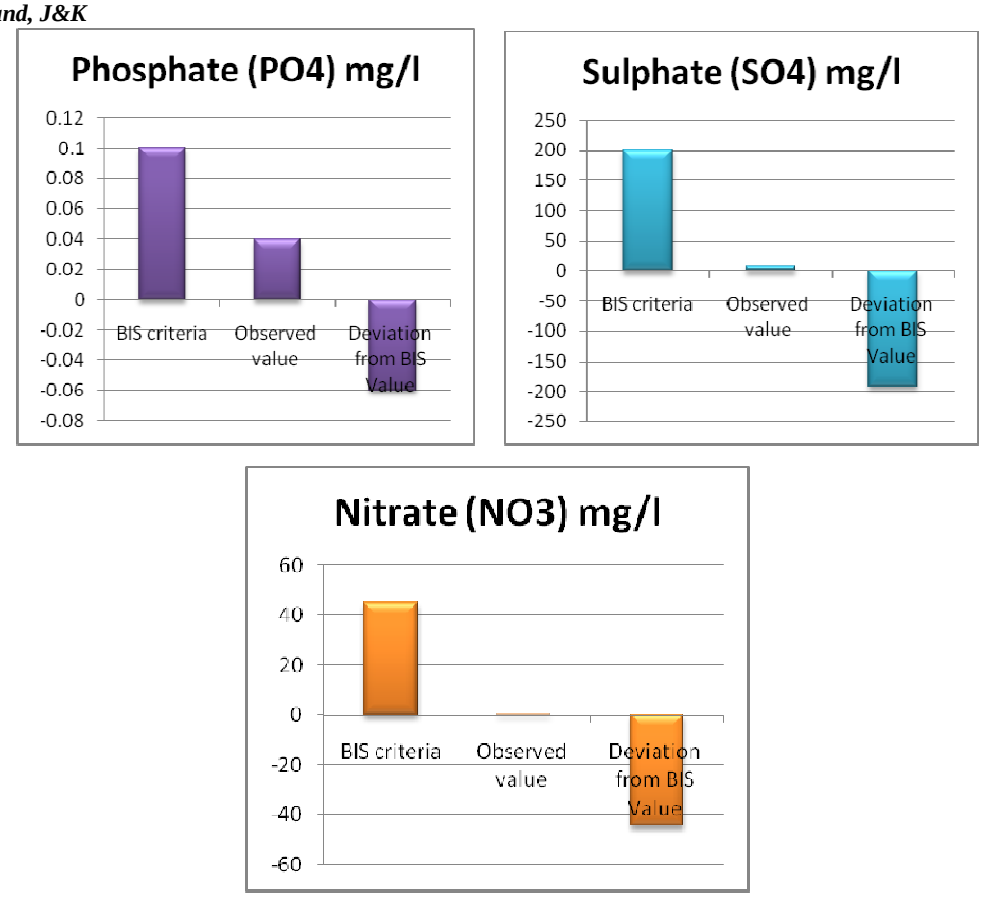


Figure 4

CONCLUSIONS

The Mansar wetland located in the shiwaliks provides the best scenic beauty. It is also popular for the aesthetic value. An attempt has been made in this study to examine the status of land use/ land cover (LULC) of the Mansar Wetland between 2008 and 2018. Among all the land use/ land cover classes taken under study moderate dense forest shows highest increase in its area, it increases by 151.26 hectares. In 2008, area under open forest was 2828.66 hectares, but in 2018 open forest area declined to 2671.07 in 2011 with a negative change of 157.59 hectares. Barren land declined by 6.37 hectare and scrub decreased by 5.66 hectares. Moreover settlement and agriculture land increases. There is no change in water body, although are some seasonal fluctuations in the Mansar wetland. The detail analysis shows that there are negative changes in some classes due to their transformation into other classes e.g. open forest area is converted into moderate dense forests and settlement and barren land is converted into agriculture land. Analysis of some physico-chemical parameters of water of Mansar Wetland like water temperature. e, transparency, turbidity, pH, electrical conductivity, TDS bicarbonate, dissolved oxygen, calcium, magnesium, sodium, chloride, phosphate, sulphate and nitrate revealed well marked seasonal fluctuations. Also these parameters show both positive as well as negative deviations when compared with BIS standard. In all these parameters, dissolved oxygen (DO) in wetland is less than 4.87mg/ltr although it should be more than 6 mg/ltr as per National Environment Standard. This DO is necessary for good water quality and healthy aquatic life. But it clearly indicates a threat to aquatic life.

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